Relative concentrations of dissolved species

**1.** When chlorine gas is added to water, the equation for the reaction is:

Cl2(*g*) + H2O() ⇌ HCl(*aq*) + HOCl(*aq*)

**(a) (i)** Write an equation for the reaction of the weak acid, hypochlorous acid, HOCl, with water.

**(ii)** List all the species present when HOCl reacts with water, in order of decreasing concentration.

Justify your order.

**2.** **(a)** 1 mol of each of the following substances was placed in separate flasks, and water was added to these

flasks to give a total volume of 1 L for each solution, rank these solutions in order of increasingpH.

Justify your choice and include equations where appropriate.

CH3NH3Cl

CH3NH2

HCl

**(b)** The conductivity of the 1 mol L–1 solutions formed in (a) can be measured, rank these solutions in order

of **decreasing** conductivity. Compare and contrast the conductivity of each of the 1 mol L–1 solutions, with

reference to species in solution.

**3. a) i)** Write an equation for the reaction of methanoic acid with water.

**ii)** Methanoic acid, HCOOH, is a weak acid. A dilute aqueous solution of this acid has a pH of 2.78.

List all the species in the aqueous solution of methanoic acid in order of decreasing concentration.

Give reasons for you answer.

**b)** Justify the variation in the properties (pH and conductivity) for the four dilute aqueous solutions

described in the table below.

|  |  |  |
| --- | --- | --- |
|  | **pH** | **Conductivity** |
| HCl | 1.0 | high |
| NH4Cl | 5.1 | high |
| NH3 | 11.1 | low |
| NaOH | 13.0 | high |

**4. (a)** Write equations for the reactions occurring when each of the following is added to water.

**(i)** HCl

**(ii)** CH3NH2

**(iii)** NH4Cl

**(b)** For each of the following 0.100 mol L–1 solutions, list all species in order of **decreasing** concentration.

*Do not include water.*

**(i)** HCl

**(ii)** CH3NH2

**(iii)** NH4Cl

**(c)** Compare and contrast the pH and electrical conductivity of 0.100 mol L–1 solutions of HCl, CH3NH2

and NH4Cl. *No calculations are necessary.*

**5. a)** Classify the following 0.100 mol L–1 solutions by writing the correct description from the terms below.

**strong acid weak acid neutral weak base strong base**

**NH3 NaCl NH4Cl HF**

**b)** Discuss the relative concentrations of the species present in each of the 0.100 mol L–1 solutions of NH3

and HF. *You do not need to include water.*

Include in your answer:

• any relevant equations

• a ranking of the species present in each solution in order of **decreasing** concentration

• justification for the ranking of the species.

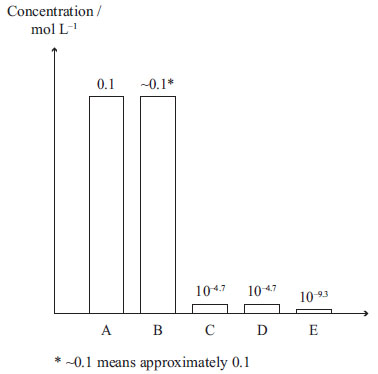
*No calculations are necessary.*

**6.** **a)** An aqueous solution of ammonium chloride (NH4Cl) has a pH of 4.66.

**(i)** Write the equation for solid ammonium chloride dissolvingin water.

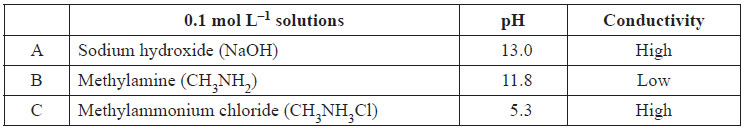
**(ii)** Write the equation for the ammonium ion reacting with water.

**(b)** The bar chart below shows the relative concentrations of the species (excluding water) in a solution of 0.1 mol L–1 NH4Cl. (The bar chart is not drawn to scale.)



Identify the species **A** to **E**. Justify your answer.

**7.** The following table lists some properties of aqueous solutions of sodium hydroxide, methylamine and methylammonium chloride.



The solutions above were prepared by adding the compounds to water.

**(a)** Write equations for the reactions occurring when each of the three compounds are added to water.

NaOH(*s*)

CH3NH2(*g*)

CH3NH3Cl(*s*)

**(b)** Justify the differences in the pH and conductivity of the three solutions.

**8.** When bromine is added to water, it forms hypobromous acid (HOBr), a weak acid.

Write an equation to show the equilibrium system that is formed with hypobromous acid and water.

**9. (a) (i)** For each of the following 0.1 mol L–1 solutions, write an equation to show the reaction with water.

CH3NH2

NH4Cl

(ii) List all the species in each of the following 0.1 mol L–1 aqueous solutions in order of **decreasing**

concentration. **Do not include H2O.**

CH3NH2

NH4Cl

(b) Explain why aqueous aminomethane, CH3NH2, is a weak electrolyte.

**10)** The boxes below show particle representations of the species (excluding water) in four aqueous solutions.

|  |  |  |
| --- | --- | --- |
| A |  | B |
| 90700q1a |  | 90700q1b |
| C |  | D |
| 90700q1c |  | 90700q1d |
| 90700q1i = HA 90700q1ii = A– 90700q1iii= H3O+ | | |

Choose the box that **best** illustrates each of the solutions (i)–(iii) below. In each case, give a reason for

your answer.

**i)** A dilute solution of a strong acid

**ii)** A concentrated solution of a weak acid

**iii)** A buffer solution

**11.** Arrange the following 0.1 mol L–1 solutions in order of increasing pH.

NH3

NH4Cl

HCl

NaCl

NaOH

Give reasons for arranging in this order, including equations for any reactions occurring to produce

solutions that **do not** have a pH of 7.

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